Check List the journal of biodiversity data

ANNOTATED LIST OF SPECIES

Check List 15 (6): 1055–1069
https://doi.org/10.15560/15.6.1055

PENSOFT

First checklist on the amphibians and reptiles of Mount Korbu, the second highest peak in Peninsular Malaysia

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Abstract

This study represents the first report on the amphibians and reptiles of Mount Korbu, the highest peak in the Titiwangsa Range (2182 m a.s.l.) and the second highest peak in Peninsular Malaysia. The Titiwangsa Range is the longest and most contiguous mountain range in Peninsular Malaysia, but only three upland localities have been extensively sampled and published on, indicating the urgent need for fieldwork to new localities along this range. We documented 18 species of amphibians from the families Bufonidae, Dicroglossidae, Megophryidae, Microhylidae, Ranidae, and Rhacophoridae and 16 species of reptiles from the families Agamidae, Gekkonidae, Scincidae, Colubridae, Pareidae, Viperidae, Testudinidae, and Trionychidae. This study also records significant range extensions for four species and provides the first collated checklist on the herpetofauna of the Titiwangsa Range.

Keywords

Herpetofauna, new records, range extensions, Titiwangsa Range.

Academic editor: Perry L. Wood, Jr. | Received 27 August 2019 | Accepted 27 October 2019 | Published 6 December 2019

Citation: Chan KO, Muin MA, Anuar S, Andam J, Razak N, Aziz MA (2019) First checklist on the amphibians and reptiles of Mount Korbu, the second highest peak in Peninsular Malaysia. Check List 15 (6): 1055–1069. https://doi.org/10.15560/15.6.1055

Introduction

Mountain ranges in Peninsular Malaysia harbour a high proportion of the region's biodiversity and, more importantly, serve as bastions of herpetological endemicity (Smedley 1931; Grandison 1972; Dring 1979; Lim et al. 2002; Leong and Lim 2003b; Grismer et al. 2008, 2009, 2010, 2013a; Wood et al. 2008, 2009; Matsui 2009; Matsui et al. 2009, 2014; Loredo et al. 2013; Chan et al. 2014, 2017, 2018; Grismer et al. 2015, 2018; Sumarli et al. 2015; Davis et al. 2016). This is in part due to their dynamic geological history, complex physiographic structure, and extensive coverage that encompasses much of the inland regions of Peninsular Malaysia (Metcalfe 2011; Searle et al. 2012). Three main mountain ranges trifurcate longitudinally from north to south (Fig. 1). The Bintang Range is the shortest and is located along the northwestern coast, while the highly fragmented Timur Range splays across a large portion of the northeastern region. The most extensive and contiguous of these mountain ranges is the centrally located Titiwangsa Range, which originates in southern Thailand and extends approximately

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480 km southwards, forming the backbone of the Malay Peninsula (Gupta 2005; Metcalfe 2011; Fig. 1).

Even though these mountain ranges maintain large tracts of forest cover, systematic surveys have only been conducted at a few sites, largely due to acute topographic relief and lack of vehicular access (Fig. 1). Because mountainous regions are known to harbour high levels of biodiversity and are important drivers of diversification and bioregionalization (Antonelli 2017; Antonelli et al. 2018), the dearth of sampling in these areas constitutes a large gap in the understanding of the region's biodiversity. This is exemplified by recent sampling efforts that were specifically targeted at surveying new upland localities, which led to the discovery of numerous new species (Grismer et al. 2013a, 2013b, 2014, 2015; Chan et al. 2014; Sumarli et al. 2015; Davis et al. 2016).

Mount Tahan (2187 m) in the Timur Range is the highest peak in Peninsular Malaysia, and is known to harbour numerous endemic species of amphibians and reptiles (Boulenger 1908; Smith 1922, 1924; David and Pauwels 2004). However, while being only 5 m lower than Mount Tahan, Mount Korbu (2182 m) in the Titiwangsa Range has never been surveyed for herpetofauna (Fig. 1). Furthermore, Mount Korbu is part of the Kinta Valley Geopark, which is recognized as an important site for biodiversity and geological heritage. In July 2019, a scientific expedition was jointly organized by the Perak Department of Mineral and Geoscience, Perak Forestry Department, and Perak State Parks to survey the biodiversity of Mount Korbu. Here, we present the expedition's herpetofaunal findings, which represent the first report on the amphibians and reptiles of Mount Korbu and only the third for the extensive Titiwangsa Range.

Methods

Sampling was conducted from 2–6 July 2019 at two main sites: Seroja Camp (796 m a.s.l; 04°39.415′N, 101° 16.333′E) and Kijang Camp (1092 m a.s.l; 04°40.482′N, 101°16.788′E; Fig. 1). Additional sampling was made at spots between these main sites for which no geographic coordinates were collected; these are listed in Materials examined but without geographic coordinates. Visual encounter surveys were performed during the day and night with emphasis along forest trails and streams around and adjacent to the sampling sites. Because this expedition was a rapid biodiversity survey, collections were done opportunistically as opposed to employing fixed transects or quadrats. High quality digital images were taken of live specimens prior to their euthanization using MS-222. Liver tissue was dissected from euthanized specimens and stored in 95% ethanol for future

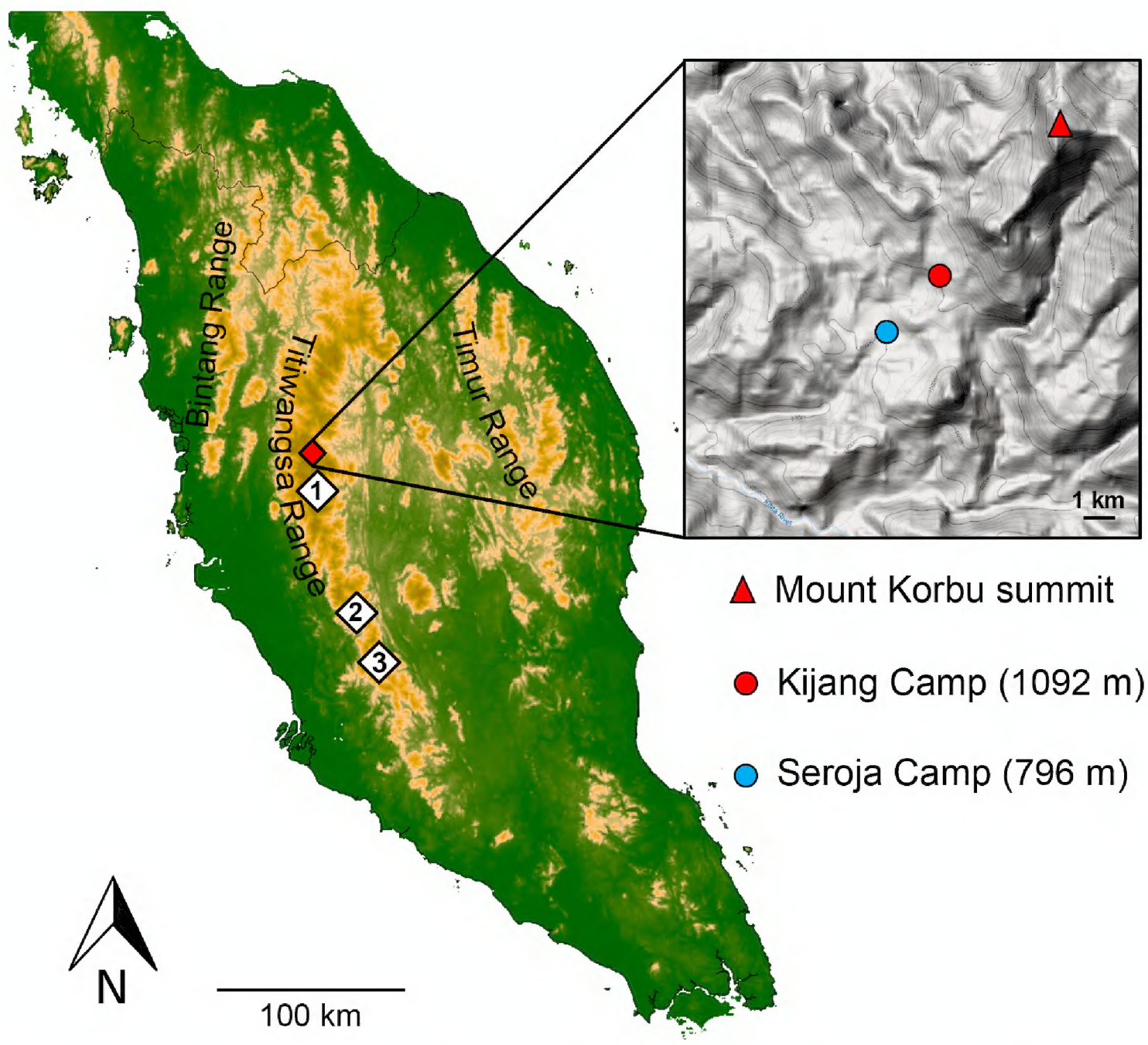


Figure 1. Relief map depicting Peninsular Malaysia's mountain ranges. White diamond symbols denote upland localities (>1000 m) along the Titiwangsa Range where systematic surveys of amphibians and reptiles have been conducted and published (1 = Cameron Highlands; 2 = Fraser's Hill; 3 = Genting Highlands). Red diamond symbol shows the location of Gunung Korbu. Inset shows the topographic map of Gunung Korbu and the location of sampling sites.

molecular studies. Specimens were then preserved using 15% formalin before being transferred to 70% ethanol for long-term storage. Collected specimens are deposited at the Department of Wildlife and National Parks, Malaysia (PERHILITAN; specimen code GK) and Herpetological Collection of the Zoological Reference Collection at the Lee Kong Chian Natural History Museum, Singapore (LKCNHM; specimen code HC). Vouchered photographs were deposited at the Zoological Reference Collection image archives [ZRC(IMG)]. Positively identified specimens that were collected or photographed were considered "confirmed", whereas specimens that were only observed but not collected were considered "unconfirmed". For taxonomic consistency, amphibian nomenclature follows the Amphibian Species of the World database (Frost 2019), while reptile nomenclature follows The Reptile Database (Uetz et al. 2019). Specimen collection was done with the permission of the Forestry Department of Perak and the Department of Wildlife and National Parks, Malaysia.

Results

We recorded 18 species of amphibians from the families Bufonidae, Dicroglossidae, Megophryidae, Microhylidae, Ranidae, and Rhacophoridae and 16 species of reptiles from the families Agamidae, Gekkonidae, Scincidae, Colubridae, Pareidae, Viperidae, Testudinidae, and Trionychidae. Below, we provide detailed accounts for each confirmed species and a collated checklist for the Titiwangsa Range (Table 1), which includes records from Fraser's Hill, Cameron Highlands, and Genting Highlands (Berry 1975, Tweedie 1983, Lim et al. 2002, Leong and Lim 2003, Ahmad et al. 2011, Grismer 2011, Manthey and Denzer 2014, Grismer et al. 2015, 2018, Davis et al. 2016, Grismer and Quah 2019).

Frogs

Family Bufonidae

***Ansonia jeetsukumarani* Wood, Grismer, Ahmad & Senawi, 2008**

Figure 2

Materials examined. Kijang Camp (04°40.482′N, 101° 16.788′E), 3 July 2019 (HC1003–06); Seroja Camp (04° 39.415′N, 101°16.333′E), 2 July 2019 (HC1022).

Identification. Tympanum visible; skin on dorsum sparsely covered with irregularly sized tubercles; tubercles on dorsolateral region and flanks enlarged; rictal tubercle slightly enlarged; dorsal color nearly uniform dark brown or black with a faint spot between the shoulders and whitish tubercles on lower flanks; yellowish-brown patch on proximal part or brachium, palm, elbow,

Table 1. Collated checklist of the amphibians and reptiles of the Titiwangsa mountain range. Asterisks (*) denote new records; dagger (†) denotes an unconfirmed record. This list was compiled from results of this study as well as published works of Berry (1975), Tweedie (1983), Lim et al. (2002), Leong and Lim (2003b), Ahmad et al. (2011), Grismer (2011), Manthey and Denzer (2014), Grismer et al. (2015, 2018), Davis et al. (2016), and Grismer and Quah (2019).

Taxa	Mount Korbu	Fraser's Hill	Cameron Highlands	Genting Highlands
Caecilians				
Icthyophidae				
Icthyophis sp.		X	X	
Frogs				
Bufonidae				
Ansonia jeetsukumarani	X	X		
Ansonia smeagol				X
Duttaphrynus melanostictus			X	X
Ingerophrynus parvus	X			X
**Leptophryne borbonica*	X			
Pelophryne signata				X
Phrynoidis asper	X	X	X	X
Dicroglossidae				
Limnonectes blythii	X	X	X	
Limnonectes hascheanus				X
Limnonectes laticeps		X	X	X
Limnonectes nitidus		X	X	X
Limnonectes plicatellus	X	X		X
Limnonectes selatan	X			X
**Limnonectes tweediei*	X			
Megophryidae				
Leptobrachella kecil			X	
Leptobrachella sola	X	X		
Leptobrachium hendricksoni				X
Megophrys aceras		X	X	X
Megophrys longipes		X	X	
Megophrys nasuta	X	X	X	X
Microhylidae				
Kalophrynus kiewi				X
Kalophrynus yongi			X	
Metaphrynella pollicaris	X	X	X	X
Microhyla annectens			X	
Microhyla berdmorei				X
Microhyla butleri		X		X
Microhyla heymonsi				X
Phrynella pulchra				X
Ranidae				
Abavorana luctuosa	X	X	X	X
Amolops larutensis	X	X	X	X
Chalcorana labialis	X	X		X
Hylarana erythraea				X
Odorrana hosii	X	X	X	X
Pulchrana banjarana	X	X	X	X
Pulchrana glandulosa		X		
Pulchrana picturata	X			X
Rhacophoridae				
Nyctixalus pictus			X	X
Philautus larutensis	X	X	X	X

Table 1. *Continued.*

Taxa	Mount Korbu	Fraser's Hill	Cameron Highlands	Genting Highlands
Philautus vermiculatus		X	X	X
Polypedates leucomystax		X	X	
Rhacophorus bipunctatus		X	X	X
Rhacophorus nigropalmatus			X	
Rhacophorus prominanus		X	X	X
Rhacophorus robinsonii			X	
Theloderma aspera		X	X	X
Theloderma leprosa		X	X	
Theloderma licin			X	
Lizards				
Agamidae				
Acanthosaura titiwangsaensis		X	X	
Aphaniotis fusca	X			X
Bronchocella cristatella	X	X	X	X
Bronchocella shenlong			X	
Draco blanfordii		X	X	
Draco formosus	X	X		
Draco haematopogon		X		
Draco melanopogon	X	X		
Draco quinquefasciatus		X		
Gonocephalus belli		X	X	X
Gonocephalus grandis	X			X
Malayodracon robinsonii			X	X
Pseudocalotes drogon		X		
Pseudocalotes flavigula			X	
Pseudocalotes rhaegal			X	
Pseudocalotes viserion				X
Dibamidae				
Dibamus floweri		X		
Eublepharidae				
Aeluroscalabotes felinus		X		
Gekkonidae				
Cnemaspis flavolineata		X		
Cnemaspis temiah			X	
Cyrtodactylus australotitiwangsaensis		X		X
Cyrtodactylus consobrinus	X		X	X
Cyrtodactylus elok	X	X	X	
Cyrtodactylus quadrivirgatus	X	X		X
Cyrtodactylus trilatofasciatus			X	
Gehyra mutilata		X	X	X
Gekko monarchus		X	X	X
Gekko smithii		X	X	X
Hemidactylus frenatus		X		
Hemiphyllodactylus titiwangsaensis		X	X	X
Ptychozoon horsfieldii			X	X
Ptychozoon kuhlii		X	X	X
Scincidae				
Dasia olivacea				X
Eutropis multifasciata	X	X	X	
**†Eutropis rugifera*	X			
Larutia miodactyla		X	X	X
Larutia trifasciata		X	X	
Lipinia vittigera		X		
Sphenomorphus cameronicus			X	
Sphenomorphus indicus		X	X	
Sphenomorphus praesignis		X	X	
Sphenomorphus senja			X	
Sphenomorphus stellatus		X	X	X
Tytthoscincus bukitensis		X		X
Tytthoscincus jaripendek			X	
Tytthoscincus kakikecil		X	X	X
Tytthoscincus martae		X		X
Varanidae				
Varanus dumerilii		X	X	
Varanus rudicollis		X	X	
Varanus salvator		X		
Snakes				
Colubridae				
Ahaetulla prasina	X		X	
Boiga cynodon			X	
Boiga jaspidea			X	
Calamaria lovii		X	X	
Calamaria lumbricoidea		X	X	
Calamaria schlegeli		X		
Chrysopelea paradisi			X	
Collarhabdium williamsoni		X	X	
Dendrelaphis cyanochloris	X		X	
Dendrelaphis caudolineatus			X	
Dendrelaphis pictus			X	
Elaphe taeniura		X	X	
Gongylosoma baliodeira		X		
Gonyosoma prasinum		X	X	
Hebius inas		X	X	
Hebius sanguineum			X	
Hebius sarawacense			X	
Lycodon butleri		X	X	
Lycodon effraenis			X	
Lycodon subcinctus			X	
Macrocalamus gentingensis				X
Macrocalamus chanardi		X	X	
Macrocalamus schulzi			X	
Macrocalamus tweediei			X	X
Oligodon purpurascens		X	X	
Oreocryptophis porphyraceus			X	
Psammodynastes pulverulentus		X	X	
Pseudorabdion longiceps		X	X	
Pseudoxenodon macrops			X	
Ptyas korros			X	
Rhabdophis chrysargos		X	X	
Rhabdophis conspicillatus			X	
Sibynophis collaris		X	X	
Xenelaphis ellipsifer			X	
Cylindrophiidae				
Cylindrophis ruffus			X	
Elapidae				
Calliophis bivirgatus			X	
Calliophis gracilis		X		
Calliophis intestinalis		X	X	
Naja sumatrana			X	
Pareidae				
Asthenodipsas lasgalenensis		X	X	
Asthenodipsas vertebralis			X	
Pareas carinatus	X		X	
Typhlopidae				
Argyrophis muelleri			X	
Viperidae				
Ovophis convictus		X	X	
Trimeresurus hageni			X	

Table 1. *Continued.*

Taxa	Mount Korbu	Fraser's Hill	Cameron Highlands	Genting Highlands
Trimeresurus nebularis			X	X
Trimeresurus sabahi	X	X	X	X
Xenopeltidae				
Xenopeltis unicolor			X	
Turtles				
Testudinidae				
Manouria emys emys		X		
Manouria impressa	X	X	X	
Trionychidae				
**Dogania subplana*	X			
Total = 149	**34**	**79**	**104**	**51**

knee, heel, and ankle; faint crossbars on forearms and hind limbs; iris gold. These characters are in agreement with the original description of the species (Wood et al. 2008).

Remarks. Individuals were observed at night, perched on low vegetation along clean, slow flowing streams around Seroja and Kijang Camps. Individuals occurred as low as 750 m a.s.l near Seroja Camp and as high as 1100 m a.s.l at Kijang Camp. Because this species is associated with upland areas (Wood et al. 2008), it is likely that it will also occur at higher elevations where habitat is suitable, but not much lower than 700 m where the transition from hill to lowland dipterocarp forest occurs.

***Ingerophrynus parvus* (Boulenger, 1887)**
Figure 3

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 3 July 2019 (GKA046, 064–066, 083–084, HC1011).

Identification. Tympanum visible but obscured by skin; dorsum covered with low, rounded, and conical tubercles; interorbital ridges present; parotoid glands oval; venter covered with low tubercles bearing fine spinules; dorsal color variable from gray to reddish brown; dark bars on hind limbs. These characters are in agreement with Berry (1975).

Remarks. Specimen HC1011 was found among tents at the Seroja Campsite at 794 m a.s.l. Other individuals were heard chorusing around a swampy area adjacent to a moderately large stream approximately 50 m from the Seroja Campsite. The individual depicted in Figure 3 was reddish brown and was observed calling from a muddy bank approximately 5 m from a large stream.

***Leptophryne borbonica* (Tschudi, 1838)**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 5 July 2019 (HC1023).

Identification. Tympanum indistinct, obscured by skin; hind limbs long; skin on dorsum covered with small, flat, tubercles; ventrolateral row of enlarged, spinose tubercles on outer margin of forearm and tarsus; interorbital ridges and supratympanic fold absent; parotoid gland slightly elongated, irregularly shaped; dorsal color dark brown; black interorbital bar and a series of three chevron-shaped marks on the nuchal region; a black hourglass mark on back; groin, underside of knee, and heel joint pinkish red. These characters are in agreement with Berry (1975).

Remarks. Only one individual was found hopping on the ground along the main trail approximately 500 m from Seroja Camp.

Figures 2–4. Amphibians from Gunung Korbu. **2.** *Ansonia jeetsukumarani*. **3.** *Ingerophrynus parvus*. **4.** *Phrynoidis asper*.

***Phrynoidis asper* (Gravenhorst, 1829)**
Figure 4

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 3–5 July 2019 (GKA003–005, 052, 063, 082).

Identification. Tympanum indistinct, obscured by skin; entire dorsal surface covered with irregularly sized,

spinose tubercles; gular and pectoral region covered with similar but smaller tubercles; tubercles on belly flat, not bearing spinose asperities; interorbital ridges and supratympanic fold absent; tarsal ridge distinct; parotoid gland large and round; dorsal color brown to gray with no distinct markings; hind limbs with indistinct bars. These characters are in agreement with Berry (1975).

Remarks. These toads were abundant and could be heard calling within and adjacent to all moderately sized streams at both sampling sites.

Family Dicroglossidae

***Limnonectes blythii* (Boulenger, 1920)**
Figure 5

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–5 July 2019 (GKR016, 028–035, 068–071, HC1033–34).

Identification. Vomerine teeth present; a pair of boney, fang-like, mandibular processes anteriorly; tympanum distinct; skin on dorsum smooth, sometimes with short, longitudinal ridges on the back and flanks; supratympanic fold distinct; dorsolateral fold absent; venter smooth; dorsum brown to gray; lips usually with alternating dark and light bars; some individuals have a light vertebral stripe from snout to vent and a similar stripe on the inner side of the tibia to the ankle; with or without dark blotches on flanks and indistinct crossbars on limbs; venter white, sometimes yellowish on the belly. These characters are in agreement with Berry (1975).

Remarks. Frogs were commonly observed in shallow, slow moving, and stagnant portions of streams, while some individuals were found on dry ground adjacent to streams. Multiple breeding pairs were seen along the shallow, peripheral parts of steams where males were heard calling to nearby females.

***Limnonectes plicatellus* (Stoliczka, 1873)**
Figure 6

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2 July 2019 (GKA050, 072–073); 4 July 2019 (HC1018).

Identification. Vomerine teeth present; a pair of boney, fang-like, mandibular processes anteriorly; tympanum distinct; skin on dorsum covered with dense, discontinuous, longitudinal ridges; flanks granular; dorsal surface of limbs with or without small, round tubercles bearing asperities; supratympanic fold distinct; dorsolateral fold absent; tarsal fold indistinct, flat; venter smooth; dorsum brown to reddish-brown; dark, chevron-shaped interorbital bar, bordered anteriorly with a lighter one; limbs with indistinct crossbars; belly yellow. These characters are in agreement with Berry (1975).

Remarks. Frogs were found in puddles and on a blade of a *Pandanus* plant along a small, slow-moving stream in syntopy with other anuran species such as *Leptobrachella sola*, *Pulchrana picturata*, *Chalcorana labialis*,

Figures 5–8. Amphibians from Gunung Korbu. **5.** *Limnonectes blythii*. **6.** *L. plicatellus*. **7.** *L. selatan*. **8.** *L. tweediei*.

Phrynoidis asper, *Ingerophrynus parvus*, *Limnonectes blythii*, *L. selatan*, and *Amolops larutensis*.

***Limnonectes selatan* Matsui, Belabut & Ahmad, 2014**
Figure 7

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–4 July 2019 (GKR036–038,048–049, 075–077, HC1041, 998).

Identification. Vomerine teeth present; a pair of boney, fang-like, mandibular processes anteriorly; tympanum indistinct; top of head smooth; anterior portion of dorsum rugose, covered with dense, low ridges; posterior covered with low tubercles forming interconnected ridges; flanks covered with rugose ridges lacking tubercles; enlarged tubercles on tibia and around the cloaca; dorsal coloration brown with indistinct dark spots and faint interorbital bar; fore and hindlimbs with irregular crossbars; flanks and venter creamish; throat mottled with pale gray. These characters are in agreement with the original description of the species (Matsui et al. 2014)

Remarks. Numerous individuals were found in water or on rocks around shallow tributaries and trickling portions of the stream. Juveniles were also observed on low vegetation. We identified frogs as *Limnonectes selatan*, as opposed to its morphologically similar closest relative, *L. utara*, based on the presence of dense tubercles around the cloaca (as opposed to sparse) and dark blotches along the dorsoventral border of the outer thigh (absent in *L. utara*; Matsui et al. 2014).

***Limnonectes tweediei* (Smith, 1935)**
Figure 8

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 3 July 2019 (GKA025–027, 051); Kijang Camp (04°40.482′N, 101°16.788′E), 3 July 2019 (HC999–1000).

Identification. Vomerine teeth present; a pair of boney, fang-like, mandibular processes anteriorly; tympanum present but obscured by skin; skin on dorsum smooth, flanks slightly rugose; supratympanic fold distinct; dorsolateral fold distinct anteriorly, becoming less pronounced posteriorly towards the groin; dorsum yellowish brown to dark gray; limbs with dark crossbars; venter yellow or orangish, gular region darkly mottled. These characters are in agreement with Dring (1979).

Remarks. *Limnonectes tweediei* and *L. nitidus* are morphologically similar, and the former was once considered a junior synonym of the latter (Kiew 1975). However, *L. tweediei* was subsequently removed from that synonymy by Dring (1979), who demonstrated significant morphological and ecological differences between the two taxa, including body size (*L. tweediei* are much smaller than *L. nitidus*) and altitudinal distribution (*L. tweediei* occurs up to ~900 m vs *L. nitidus* at ~1300 m). The samples we collected fell within the size range of *L. tweediei* (adult males up to 41.8 mm SVL) and were collected between 800 and 1000 m a.s.l. Frogs were relatively common in shallow, stagnant, muddy/swampy puddles that have a thick bed of leaf litter away from main streams or rivers. Males were actively calling.

Family Megophryidae

***Leptobrachella sola* (Matsui, 2006)**
Figure 9

Materials examined. Between Kijang and Seroja Camps, 3 July 2019 (HC1007, 1019); Seroja Camp, 5 July 2019 (HC1024).

Identification. Vomerine teeth absent; inner metacarpal tubercle large, outer much smaller than inner; toes webbed at base; skin weakly shagreened, infused with small tubercles, flanks with larger tubercles; dorsal coloration brown to gray with an interorbital bar; underside of supratympanic fold dark brown; dark spots below

Figures 9–11. Amphibians from Gunung Korbu. **9.** *Leptobrachella sola*. **10.** *Megophrys nasuta*. **11.** *Metaphrynella pollicaris*.

canthus and sides of snout tip; chevron or W-shaped patch on middle of back and sacral region; dark brown spots/patches on flanks and sacral region; dark crossbars on hind limbs; iris rusty brown to red. These characters are in agreement with the original description of the species (Matsui 2006).

Remarks. Frogs were mostly observed on low vegetation along slow-moving streams. Surprisingly, we also observed two invidividuals on the ground. One was adjacent to a small stream, while the other was found along a trail approximately 50 m from water. Males were heard calling during the night.

***Megophrys nasuta* (Schlegel, 1858)**
Figure 10

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2 July 2019 (GKR001, 080); Kijang Camp (04°40.482′N, 101°16.788′E), 4 July 2019 (HC1002).

Identification. Vomerine teeth present; body robust, head wide and casque-like; skin on dorsum finely granular; upper eyelids and snout form long, pointed, dermal projections; skin at angle of jaws with sharp, dermal spines; supratympanic fold set upon a boney ridge; dorsal coloration brown; chin, throat and pectoral region brown with irregular light speckling and a pair of white spots on the chest. These characters are in agreement with Berry (1975).

Remarks. Males were commonly heard calling during dusk between 1830–1930 hrs and call frequency increased significantly prior to precipitation. A juvenile was found hopping across the trail, while adults were found under leaves or shallow burrows in the ground.

Family Microhylidae

***Metaphrynella pollicaris* (Boulenger, 1890)**
Figure 11

Materials examined. Just below Kijang Camp, 3 July 2019 (HC1012).

Identification. Tympanum visible but indistinct; finger tips expanded into truncated discs not bearing circum-marginal grooves; fingers webbed at base; subarticular tubercles enlarged to form accessory adhesive pads, one each on the first and second fingers and two each on the third and fourth; prepollex conspicuous in males, not well developed in females; inner and outer metacarpal tubercles flat, indistinct; skin on dorsum rugose, covered with low ridges formed by low tubercles; venter smooth; dorsal color beige with irregular dark patches on back; limbs with dark crossbars. These characters are in agreement with Berry (1975).

Remarks. Two individuals were found at night in two separate water-filled treeholes that were 1 m and 2.5 m above ground at approximately 1000 m a.s.l. between Seroja and Kijang.

Family Ranidae

***Abavorana luctuosa* (Peters, 1871)**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2 July 2019 (GKA041).

Identification. Vomerine teeth present; tympanum distinct; skin on dorsum and venter smooth; supratympanic and dorsolateral fold absent; dorsum reddish brown with a distinct, white, dorsolateral stripe which extends continually from the tip of snout, along the canthus rostralis, upper eyelid, and to the vent; sides of head and flanks ventral to the dorsolateral stripe and dorsal surfaces of front and hind limbs dark brown to black; limbs with small, white patches forming irregular crossbars; venter light gray. These characters are in agreement with Berry (1975) and Quah et al. (2017).

Remarks. Only one individual was seen on leaves in a small stream near Seroja Camp.

***Amolops larutensis* (Boulenger, 1899)**
Figure 12

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–4 July 2019 (GKA006–011, 019, 053–058, 081, HC1042–44, 1029–32); between Seroja and Kijang Camps, 3 July 2019 (HC1001).

Identification. Vomerine teeth present; tympanum small, naked or partially covered with skin; finger tips expanded into large, horizontally elongated discs bearing transverse-dorsal, transverse-ventral, and circum-marginal grooves; skin on dorsum granular or rugose; dorsolateral surface covered with indistinct, large, flat, oval tubercles and/or short, low, longitudinal ridges; flanks more coarsely granular than dorsum, covered with similar low, oval tubercles of smaller size; dorsal color brown or grayish green with large, dark, oval, blotches which sometimes connect to form a network; flanks yellowish; limbs with wide crossbars; venter whitish with dark streaks on the gular and pectoral region. These characters are in agreement with Chan et al. (2018).

Remarks. Frogs were observed on rocks, debris, or low vegetation within and along most slow- to moderately swift-flowing streams. These frogs were the most ubiquitous frogs observed. Males were encountered more frequently than females.

***Chalcorana labialis* (Boulenger, 1887)**
Figure 13

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–5 July 2019 (GKA022, 023, 042–044; HC1037–40).

Figures 12–15. Amphibians from Gunung Korbu. **12.** *Amolops larutensis*. **13.** *Chalcorana labialis*. **14.** *Pulchrana banjarana*. **15.** *P. picturata*.

Identification. Vomerine teeth present; tympanum distinct; skin on dorsum granular; flanks rugose; supratympanic fold absent; dorsolateral fold weak or absent; throat, chest, and anterior half of abdomen smooth, posterior half rugose; dorsal color variable from light green, brownish, to pale yellow, usually with faint, dark spots on back; flanks sometimes yellowish; backs of frogs turn dark brown when handled, rendering dorsal spots distinct; lips white; limbs with faint blotches not forming distinct crossbars; venter whitish, with or without dark blotches on the gular and pectoral region. These characters are in agreement with Berry (1975).

Remarks. Frogs were observed on rocks, debris, or low vegetation along most waterways.

Odorrana hosii **(Boulenger, 1891)**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–4 July 2019 (GKA013–015, 060–062, 067; HC1028).

Identification. Vomerine teeth present; tympanum distinct; finger tips expanded into large, round discs bearing transverse-dorsal and circum-marginal grooves; skin on dorsum finely granular, not bearing any tubercles; supratympanic fold absent; dorsolateral fold glandular, rounded, may be distinct or indistinct; skin on venter smooth; dorsal color brown or green, with or without irregular, dark blotches on back; flanks brown to yellowish; dark brown preorbital stripe; lips entirely or partially white; limbs usually with dark blotches not forming distinct crossbars; venter whitish or yellowish, usually with brown mottling on throat. These characters are in agreement with Berry (1975).

Remarks. Frogs were observed on rocks, debris, or low vegetation along most waterways.

Pulchrana banjarana **(Leong & Lim, 2003)**
Figure 14

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–3 July 2019 (GKA039–040; HC976, 997); between Seroja and Kijang Camps, 3 July 2019 (HC1013).

Identification. Vomerine teeth present; tympanum distinct, naked; skin on dorsum and upper flanks covered with a polygonal mosaic of raised granules; dorsolateral fold absent; continuous, dorsolateral row of distinctly raised or low-lying chain of enlarged, fused granules; tibia with parallel rows of longitudinal dermal ridges; supratympanic fold indistinct; venter smooth; dorsal color orangish brown with black reticulations; hind limbs with black crossbars or reticulations; venter light gray to dark brown with randomly distributed white spots on the throat, belly, and/or hind limbs. These characters are in agreement with the original description of the species (Leong and Lim 2003a).

Remarks. Males were heard calling from within dense vegetation, debris, or root tangles along slow-moving streams. Frogs were found as low as 780 m a.s.l. near Seroja and as high as 1100 m a.s.l. at Kijang. Because this species is associated with upland forests, it is also expected

to occur in suitable habitats at higher elevation. Interestingly, *Pulchrana banjarana* occurs in sympatry but not in syntopy with another morphologically similar species, *P. picturata*. From our field observations, *P. banjarana* occurs in smaller and slower-moving streams, whereas *P. picturata* occurs along larger and swifter streams.

***Pulchrana picturata* (Boulenger, 1920)**
Figure 15

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2 July 2019, (GKA020–021,059; HC1035–36).

Identification. Vomerine teeth present; tympanum distinct; skin on dorsum covered with small, flat, tubercles; supratympanic fold weak to absent; with or without a dorsolateral row of low-lying chain of enlarged, fused granules; venter smooth; dorsal color black; back and flanks covered with yellow/orange spots; orange spots form a discontinuous, dorsolateral stripe which extends from tip of snout, through the upper eyelid to the groin; limbs with orange blotches which sometimes form crossbars; venter gray to brown, with or without white spots. These characters are in agreement with (Brown and Siler 2014).

Remarks. Males were commonly heard calling at night from dense vegetation, debris, or root tangles along moderate-sized to large streams.

Family Rhacophoridae

***Philautus larutensis* (Boulenger, 1900)**

Materials examined. Between Kijang and Seroja Camps, 2–3 July 2019 (GKA078–079, HC1008–10).

Identification. Vomerine teeth absent; tympanum indistinct, obscured by skin; finger tips expanded into large, horizontally elongated discs bearing circummarginal and transverse-ventral grooves; skin on dorsum finely granular with irregularly distributed, indistinct, tubercles and short ridges; supratympanic fold present; entire ventral surface including palm and sole of feet coarsely granular; dorsal color variable shades of brown from creamy to dark brown; dorsolateral stripe from behind the eye to the anal or groin region, usually forming an hour-glass shape on the back; limbs with indistinct crossbars; venter mottled grayish brown. These characters are in agreement with Berry (1975) and Wostl et al. (2017).

Remarks. Frogs were encountered on leaves approximately 1.5 m above ground near small streams or along trails far from water. Frogs were found as low as 850 m a.s.l. near Seroja and more frequently at higher elevations around Kijang.

Lizards

Family Agamidae

***Aphaniotis fusca* Peters, 1864**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 5 July 2019 (GKR020).

Identification. Body long, slender, laterally compressed; no epidermal spines on head; tympanum covered with scales; oral mucosa and iris blue; dorsal scales small; low crest of scales from nape to base of tail; body coloration brown without distinct markings. These characters are in agreement with Grismer (2011).

Remarks. Only one individual was found on a tree trunk, 1 m above ground, far from water.

***Bronchocela cristatella* (Kuhl, 1820)**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 4 July 2019 (HC1021).

Identification. Body slender, tail very long; no epidermal spines on head; tympanum distinct, not covered with scales; distinct vertebral crest on nape; body coloration green with faint, indistinct markings; posterior 2/3 or tail reddish brown. These characters are in agreement with Grismer (2011).

Remarks. A single individual was found at night sleeping on a fern frond approximately 1 m above ground along a trail near Seroja.

***Gonocephalus grandis* (Gray, 1845)**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–4 July 2019 (GKR010–011, HC1027).

Identification. No spines above eye; tympanum distinct, not covered with scales; in mature males, enlarged, discontinuous, vertebral crest along nape and body; body coloration green, flanks bluish with yellow spots; dorsal surfaces of limbs and tail with dark crossbars; in females and juveniles, body coloration light brown with dark, broad postorbital stripe extending dorsally to nape, forming a V-shaped collar; irregular dark brown patches on back; flanks creamish with faint yellow spots; dorsal surfaces of limbs and tail with dark crossbars. These characters are in agreement with Grismer (2011).

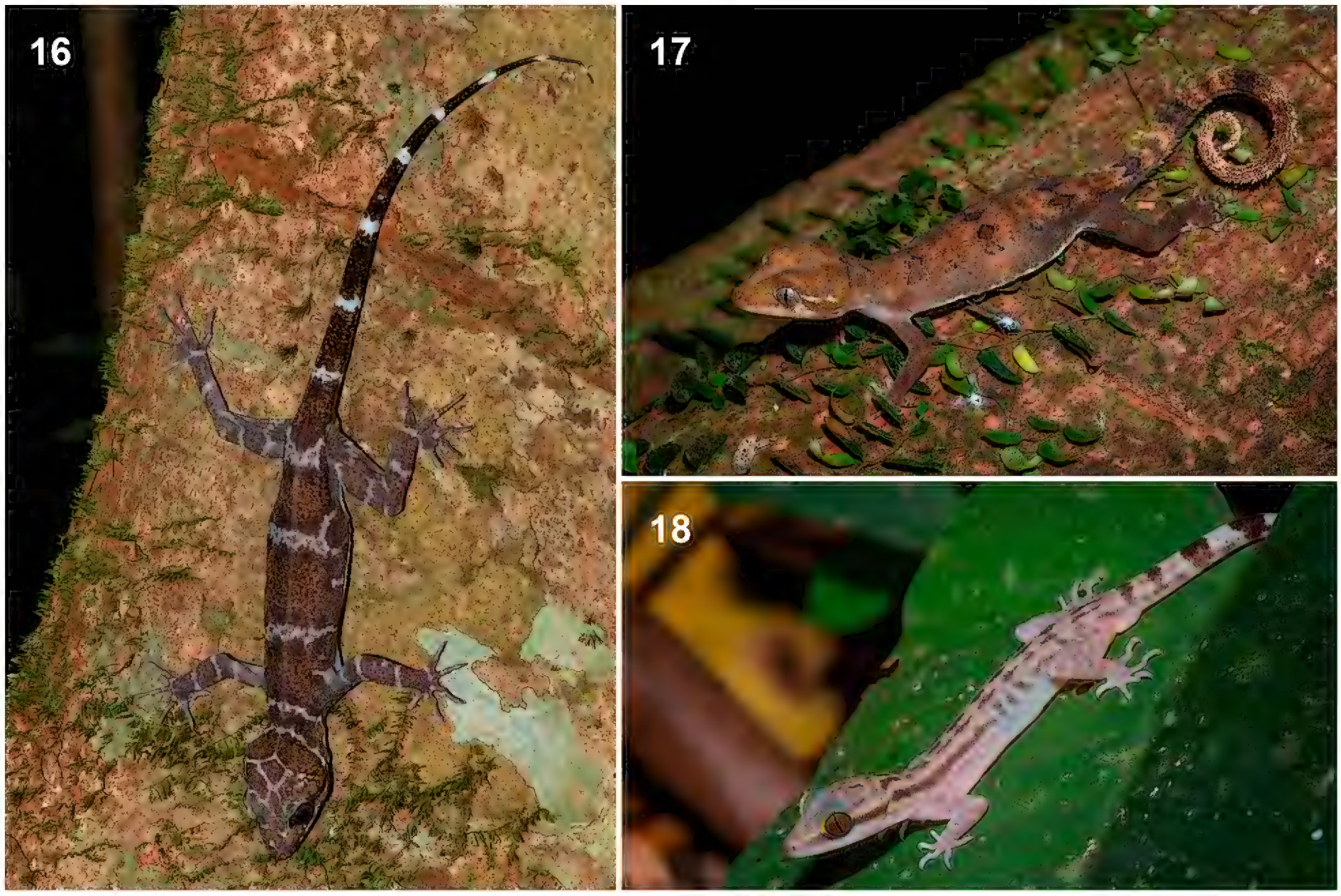
Remarks. Adults and juveniles were found sleeping on leaves and branches at last 3 m above ground along or adjacent to streams.

Family Gekkonidae

***Cyrtodactylus consobrinus* (Peters, 1871)**
Figure 16

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–5 July 2019 (GKR001, 004, 005, 014–017, HC977–78).

Identification. Body slender as juveniles, robust as adults; digits slender, inflected; dorsal surfaces covered tubercles (less pronounced in juveniles); dorsal coloration dark brown to dark gray; yellowish white mosaic pattern on top of head; three light irregular bands on body; upper lip with small, irregular white spots; white bands on dorsal surfaces of limbs and tail. These characters are in agreement with Grismer (2011).



Figures 16–18. Reptiles from Gunung Korbu. **16.** *Cyrtodactylus consobrinus*. **17.** *C. elok*. **18.** *C. quadrivirgatus*.

Remarks. Numerous juveniles and adults were observed on tree trunks low to the ground at night.

Cyrtodactylus elok **Dring, 1979**
Figure 17

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 4 July 2019 (GKR019; HC1020).

Identification. Body moderately robust; digits relatively short and slender, inflected; pupils elliptical, small; body smooth with very small, low tubercles from nap to base of tail; transversely enlarged, median subcaudal scales absent; tail prehensile, squarish in cross-section; fine, spiny fringe on tail; body brown to beige with darker irregular patches on nape and back; thin, short, pale postorbital stripe; limbs without bands; tail with dark bands anteriorly; iris silver. These characters are in agreement with Grismer (2011).

Remarks. Two individuals were found near Seroja in a patch of forest dominated by bamboo. One individual was observed on a bamboo trunk approximately 1 m above ground, while the other was found on a slender branch of a sapling approximately 3 m above ground. Specimen GKR019 was a gravid female bearing two eggs.

Cyrtodactylus quadrivirgatus **Taylor, 1962**
Figure 18

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–4 July 2019 (GKR003, 012–013); between Seroja and Kijang Camps, 3 July 2019 (HC1014–15).

Identification. Body slender; digits relatively short and slender, inflected; body covered with small, keeled tubercles; body coloration light gray to brown; dark brown postorbital stripe; pair of short, symmetrical stripes on nape forming a Y shape; dark brown stripes on body variable, sometimes forming a series of four semi-continuous stripes from nape to base of tail; dorsal surface of limbs with irregular brown patches; dark bands on tail. These characters are in agreement with Grismer (2011).

Remarks. Lizards were found on leaves or tree trunks low to the ground at night.

Snakes

Family Colubridae

Ahaetulla prasina **(Boie, 1827)**

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2 July 2019 (GKR021).

Identification. Body long, slender; iris horizontal; snout long, flat, and distinctly tapered; canthus sharp; body coloration green without distinct markings; interstitial scales checkered white and black; venter pale. These characters are in agreement with Tweedie (1983).

Remarks. One individual was found sleeping on branches approximately 3 m from ground at night.

Dendrelaphis cyanochloris **(Wall, 1921)**
Figure 19

Figures 19–21. Reptiles from Gunung Korbu. **19.** *Dendrelaphis cyanochloris*. **20.** *Pareas carinatus*. **21.** *Trimeresurus sabahi*.

Materials examined. Between Kijang and Seroja Camps, 3 July 2019 (HC975).

Identification. Body long and slender; head dorsoventrally compressed; eyes large, pupils round; scales smooth; single row of enlarged vertebral scales; top of head and body bronze in color; distinct black postorbital stripe at becomes diffused and absent past the nape; upper lip, sides of head and neck below the black stripe yellow; flanks and interstitial scales bright blue, which fades posteriorly; absence of three lateral black stripes on the posterior half of the body. These characters are in agreement with Manthey and Grossmann (1997) and Vogel and van Rooijen (2007).

Remarks. A single individual was found sleeping on a sapling approximately 5 m from ground.

Family Pareidae

***Pareas carinatus* (Boie, 1828)**
Figure 20

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 4 July 2019 (GKR009).

Identification. Body relatively short, robust; snout short, blunt; eyes large; vertebral scales slightly enlarged and keeled; body coloration light brown to tan; thin, black postorbital stripe extends and broadens to nape forming a black patch; small, irregular dark patches along vertebral column and flanks; iris gold. These characters are in agreement with Tweedie (1983).

Remarks. A single individual was found on a fern frond approximately 7 m from ground.

Family Viperidae

***Trimeresurus sabahi* Regenass & Kramer, 1981**
Figure 21

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–3 July 2019 (GKR002, 022–023).

Identification. Body relatively short and robust; head dorsoventrally compressed, triangular in dorsal profile; snout tapered to a point; heat-sensing pit below the canthus; pupils vertical; scales keeled; body coloration green without distinct markings; males with parallel white and red stripes along the dorsoventral region; tail dark red; belly yellowish green. These characters are in agreement with Wostl et al. (2016).

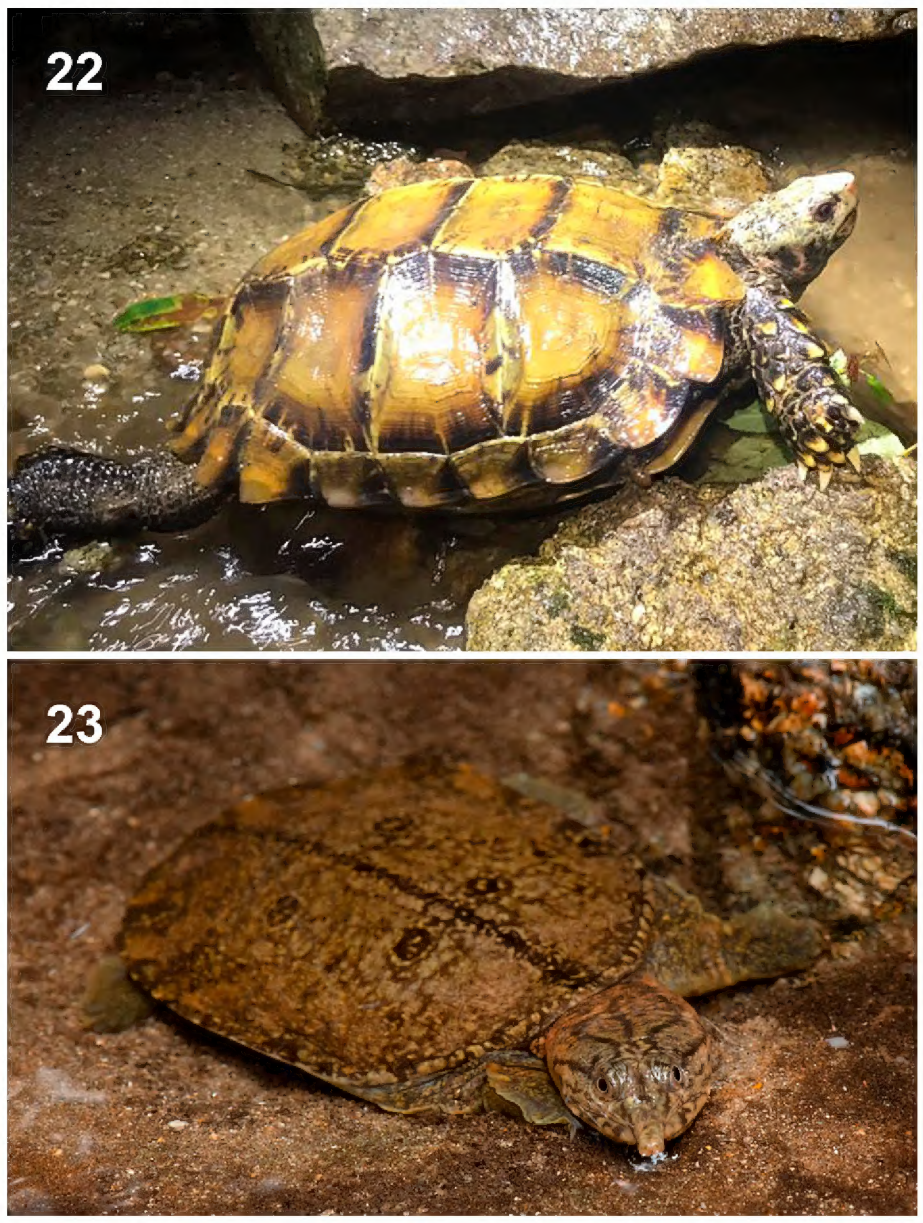
Remarks. Multiple individuals were found on the ground or on branches approximately 3–5 m above ground.

Family Testudinidae

***Manouria impressa* (Günther, 1882)**
Figure 22

Materials examined. Kijang Camp (04°40.482′N, 101° 16.788′E), 3 July 2019 (ZRC(IMG) 2.419–20).

Identification. Top of head pale; tip of snout pinkish; shell yellowish brown; margins of each scute dark brown; scutes concavely depressed; scales on front limbs



Figures 22, 23. Reptiles from Gunung Korbu. **22.** *Manouria impressa*. **23.** *Dogania subplana*.

enlarged and pointed; claws long and sharp. These characters are in agreement with Manthey and Grossmann (1997) and Auliya (2007).

Remarks. A single individual was found behind Kijang Camp. Due to the vulnerable status of this species, we withhold specific details about the finding and natural history of this species. Additional information for scientific purposes can be obtained from the authors upon request.

Family Trionychidae

***Dogania subplana* (Geoffroy, 1809)**
Figure 23

Materials examined. Seroja Camp (04°39.415′N, 101° 16.333′E), 2–3 July 2019 (GKR007, 008,024–031).

Identification. Head relatively large, neck long; nose elongated and pointed; carapace flat; coloration brown with two pairs of black paravertebral spots; dark vertebral stripe composed of small, dense spots; top of head with a series of dark stripes. These characters are in agreement with Manthey and Grossmann (1997) and Auliya (2007).

Remarks. This species was commonly found in most streams around Seroja Camp.

Discussion

Results from this study fill an important gap in the understanding of the distribution and biodiversity of Peninsular Malaysia's amphibians and reptiles. Despite being the most extensive mountain range in Peninsular Malaysia, Gunung Korbu represents only the fourth upland locality on the Titiwangsa Range that has been surveyed for amphibians and reptiles and constitutes the northernmost sampled locality after Cameron Highlands (Smedley 1931; Lim et al. 2002; Ahmad et al. 2011). From Gunung Korbu, the Titiwangsa Range extends continuously northward for at least another 150 km. Surprisingly, that entire northern region has never been adequately surveyed for amphibians and reptiles, thereby highlighting the dire need for more sampling effort in the upland regions of Peninsular Malaysia.

This study documented 34 species of amphibians and reptiles, which is relatively low compared to other well-studied, systematically surveyed upland regions such as Gunung Tebu (Sumarli et al. 2015), Bukit Larut (Grismer et al. 2010), Fraser's Hill (Ahmad et al. 2011), and the Cameron Highlands (Lim et al. 2002). However, this is primarily due to limited sampling effort as we only conducted five days of sampling compared to surveys over the course of many years for the other localities. Nevertheless, within that short period, we managed to document two species of amphibians (*Leptophryne borbonica*, *Limnonectes tweediei*) and two species of reptiles (*Eutropis rugifera*, *Dogania subplana*) that represent new records for the Titiwangsa Range, indicating that the true extent of herpetofaunal diversity in Gunung Korbu and the Titiwangsa Range, in general, is still underestimated.

Acknowledgements

We thank the Perak Deparment of Mineral and Geoscience, Perak Forestry Department, and Perak State Parks for organizing and hosting the expedition. Research by Shahrul Anuar was supported by Universiti Sains Malaysia Grants (811311 and 870039).

Author's Contributions

KOC collected specimens and wrote the manuscript. All other authors helped with fieldwork.

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